

CLAIMS

1. A plasma processing apparatus for applying a process to a substrate (114) to be processed, the plasma processing apparatus comprising a chamber (101) of which interior can be depressurized, a gas supply system for supplying a gas to the chamber and an exhaust system for exhausting the gas supplied to the chamber and for depressurizing the chamber; a part of a wall constituting the chamber (101) being a flat plate dielectric material plate (102) formed of a material which passes a microwave therethrough substantially without a loss; a flat plate dielectric material shower plate (103), which is formed of a material which passes a microwave therethrough substantially without a loss, being provided between the dielectric material plate and plasma excited in the chamber; a plurality of gas discharge holes (107) being formed in the dielectric material shower plate so that at least a part of the gas supplied by the gas supply system is discharged through the plurality of gas discharge holes (107) through a gap (104) between the dielectric material plate (102) and the dielectric material shower plate (103); a flat plate slot antenna (110) being provided on an outer side of the chamber (101) with the dielectric material plate (102) interposed therebetween so as to supply a microwave for exciting plasma through the dielectric material plate; an electrode (115) being provided on an inner side of the chamber so as to hold the substrate (114) to be processed,

30 characterized in that a lattice-like shower plate (111; 600; 700) is provided between the dielectric material shower plate (103) and the substrate (114) to be processed so as to discharge a gas, which has a

composition different from that of the gas discharged from the dielectric material shower plate, to a side of the substrate to be processed; and

5 at least a part of the gas discharged from the dielectric material shower plate (103) flows to the side of the substrate to be processed by being passed through an opening part (206; 607; 707) of the lattice-like shower plate.

10 2. The plasma processing apparatus as claimed in claim 1, characterized in that said lattice-like shower plate (111; 600) is formed of a metal pipe; a plurality of gas discharge holes (203; 603) are provided to the metal pipe on a side facing the substrate to be processed; and  
15 the metal pipe is grounded.

3. The plasma processing apparatus as claimed in claim 2, characterized in that said metal pipe is formed of a stainless steel containing aluminum, and a  
20 surface thereof is covered by a passivation film mainly formed of aluminum oxide.

4. The plasma processing apparatus as claimed in claim 1, characterized in that said dielectric material shower plate (103) and said lattice-like shower plate (111; 600; 700) are arranged substantially parallel to each other, and a distance therebetween is substantially equal to a multiple of a quarter of a wavelength of said microwave in a vacuum.

30 5. The plasma processing apparatus as claimed in one of claims 1 to 4, characterized in that said dielectric material plate (102) and said dielectric

material shower plate (103) are arranged substantially parallel to each other, and a distance between a surface of said dielectric material plate (102) facing said slot antenna and a surface of said dielectric material shower plate (103) facing said substrate to be processed is substantially equal to an odd multiple of a quarter of a wavelength of said microwave in a corresponding part.

6. The plasma processing apparatus as claimed  
10 in claim 5, characterized in that said slot antenna (110) and said dielectric material plate (102) are arranged substantially parallel to each other, and a distance therebetween is substantially equal to an odd multiple of a quarter of a wavelength of said microwave in a  
15 corresponding part.

7. The plasma processing apparatus as claimed  
in one of claims 1 to 4, characterized in that a thickness  
20 of said dielectric material shower plate (103) is an integral multiple of a half of a wavelength of said microwave in a corresponding part.

8. The plasma processing apparatus as claimed  
in claim 7, characterized in that said slot antenna (110)  
25 and said dielectric material plate (102) are arranged substantially parallel to each other, and a distance therebetween is substantially equal to an odd multiple of a quarter of a wavelength of said microwave in a corresponding part.

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9. A plasma processing apparatus for applying a process to a substrate (812) to be processed, the plasma processing apparatus comprising a chamber (801) of which

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interior can be depressurized, a gas supply system for supplying a gas to the chamber and an exhaust system for exhausting the gas supplied to the chamber and for depressurizing the chamber; a part of a wall constituting

5 the chamber (801) being a flat plate dielectric material plate (802) formed of a material which passes a microwave therethrough substantially without a loss; a part of a wall of the chamber other than the dielectric material plate is a grounded metal wall; a flat plate dielectric

10 material shower plate (803), which is formed of a material which passes a microwave therethrough substantially without a loss, being provided between plasma excited in the chamber and each of the dielectric material plate (802) and the metal wall; a plurality of gas discharge

15 holes (807) being formed in the dielectric material shower plate so that at least a part of the gas supplied by the gas supply system is discharged through the plurality of gas discharge holes (807) through a gap (804) between the metal wall and the dielectric material shower plate (803);

20 a single mode waveguide (808) having a wall a part of which is the dielectric material plate (802) being provided on an outer side of the chamber (801) with the dielectric material plate (802) interposed therebetween; an electrode (813) being provided on an inner side of the

25 chamber so as to hold the substrate (812) to be processed, characterized in that a lattice-like shower plate (809) is provided between the dielectric material shower plate (803) and the substrate (812) to be processed so as to discharge a gas, which has a composition

30 different from that of the gas discharged from the dielectric material shower plate, to a side of the substrate to be processed; and at least a part of the gas discharged from the

dielectric material shower plate (803) flows to the side of the substrate to be processed by being passed through an opening part of the lattice-like shower plate (809).

5           10. The plasma processing apparatus as claimed in claim 9, characterized in that said lattice-like shower plate (809) is formed of a metal pipe; a plurality of gas discharge holes (811) are provided to the metal pipe on a side facing the substrate to be processed; and the metal  
10 pipe is grounded.

11. The plasma processing apparatus as claimed in claim 10, characterized in that said metal pipe is formed of a stainless steel containing aluminum, and a  
15 surface thereof is covered by a passivation film mainly formed of aluminum oxide.

12. The plasma processing apparatus as claimed in one of claims 9 to 11, characterized in that said dielectric material shower plate (803) and said lattice-like shower plate (809) are arranged substantially parallel to each other, and a distance therebetween is substantially equal to a multiple of a quarter of a wavelength of said microwave in a vacuum.

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13. A plasma processing apparatus for applying a process to a substrate to be processed, the plasma processing apparatus comprising a chamber (101) of which interior can be depressurized, a gas supply system for supplying a gas to the chamber and an exhaust system for exhausting the gas supplied to the chamber and for depressurizing the chamber; a part of a wall constituting the chamber being a flat plate dielectric material plate

(102) formed of a material which passes a microwave therethrough substantially without a loss; a flat plate dielectric material shower plate (103), which is formed of a material which passes a microwave therethrough

5       substantially without a loss, being provided between the dielectric material plate and plasma excited in the chamber; a plurality of gas discharge holes (107) being formed in the dielectric material shower plate so that at least a part of the gas supplied by the gas supply system

10      is discharged through the plurality of gas discharge holes (107) through a gap (104) between the dielectric material plate (102) and the dielectric material shower plate (103); a flat plate slot antenna (110) being provided on an outer side of the chamber (101) with the dielectric

15      material plate (102) interposed therebetween so as to supply a microwave for exciting plasma through the dielectric material plate; an electrode (115) being provided on an inner side of the chamber so as to hold the substrate (114) to be processed,

20           characterized in that the slot antenna (110), the dielectric material plate (102) and the dielectric material shower plate (103) are arranged substantially parallel to each, and a distance between a surface of the dielectric material plate (102) facing said slot antenna and a surface of said dielectric material shower plate (103) facing said substrate to be processed is substantially equal to an odd multiple of a quarter of a wavelength of said microwave in a corresponding part.

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30           14. The plasma processing apparatus as claimed in claim 13, characterized in that a thickness of said dielectric material shower plate (103) is an integral multiple of a half of a wavelength of said microwave in a

corresponding part.

15. The plasma processing apparatus as claimed  
in claim 13 or 14, characterized in that a distance  
5 between said slot antenna (110) and said dielectric  
material plate (102) is substantially equal to an odd  
multiple of a quarter of a wavelength of said microwave in  
a corresponding part.

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